EENS 1110	Physical Geology
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Sediment and Sedimentary Rocks

This page last updated on 01-Feb-2012

Sedimentary Rocks

Rivers, oceans, winds, and rain runoff all have the ability to carry the particles washed off of eroding rocks. Such material, called ***detritus***, consists of fragments of rocks and minerals. When the energy of the transporting current is not strong enough to carry these particles, the particles drop out in the process of ***sedimentation***. This type of sedimentary deposition is referred to as ***clastic sedimentation***. Another type of sedimentary deposition occurs when material is dissolved in water, and chemically precipitates from the water. This type of sedimentation is referred to as ***chemical sedimentation***. A third process can occur, wherein living organisms extract ions dissolved in water to make such things as shells and bones. This type of sedimentation is called ***biochemical sedimentation.*** The accumulation of plant matter, such as at the bottom of a swamp, is referred to as ***organic sedimentation.*** Thus, there are 4 major types of sedimentary rocks: ***Clastic Sedimentary Rocks***, ***Chemical Sedimentary Rocks***, ***Biochemical Sedimentary Rocks***, and ***Organic Sedimentary Rocks***.

Clastic Sediments and Sedimentary Rocks

The formation of a clastic sediment and sedimentary rocks involves five processes:

1. ***Weathering*** - The first step is transforming solid rock into smaller fragments or dissolved ions by physical and chemical weathering as discussed in the last lecture.
2. ***Erosion*** - Erosion is actually many process which act together to lower the surface of the earth. In terms of producing sediment, erosion begins the transpiration process by moving the weathered products from their original location. This can take place by gravity (mass wasting events like landslides or rock falls), by running water. by wind, or by moving ice. Erosion overlaps with transpiration.
3. ***Transportation*** - Sediment can be transported by sliding down slopes, being picked up by the wind, or by being carried by running water in streams, rivers, or ocean currents. The distance the sediment is transported and the energy of the transporting medium all leave clues in the final sediment that tell us something about the mode of transportation.

4. ***Deposition*** - Sediment is deposited when the energy of the transporting medium becomes too low to continue the transport process. In other words, if the velocity of the transporting medium becomes too low to transport sediment, the sediment will fall out and become deposited. The final sediment thus reflects the energy of the transporting medium.
5. ***Lithification (Diagenesis)*** - Lithification is the process that turns sediment into rock. The first stage of the process is compaction. Compaction occurs as the weight of the overlying material increases. Compaction forces the grains closer together, reducing pore space and eliminating some of the contained water. Some of this water may carry mineral components in solution, and these constituents may later precipitate as new minerals in the pore spaces. This causes cementation, which will then start to bind the individual

particles together.

Classification - Clastic sedimentary particles and sedimentary rocks are classified in terms of grain size and shape, among other factors.

Name of Particle	Size Range	Loose Sediment	Consolidated Rock
Boulder	>256 mm	Gravel	Conglomerate or Breccia (depends on rounding)
Cobble	64 - 256 mm	Gravel	
Pebble	2 - 64 mm	Gravel	
Sand	1/16 - 2mm	Sand	Sandstone
Silt	1/256 - 1/16 mm	Silt	Siltstone
Clay	<1/256 mm	Clay	Claystone, mudstone, and shale

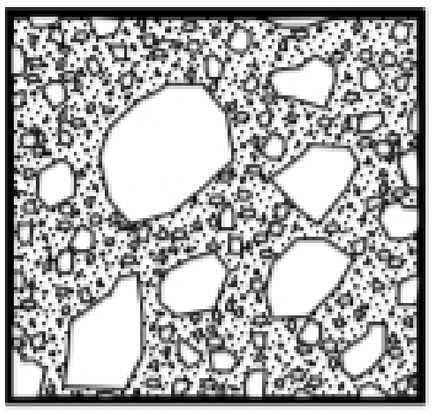
In general, the coarser sediment gets left behind by the transportation process. Thus, coarse sediment is usually found closer to its source and fine grained sediment is found farther from the source.

Textures of Clastic Sedimentary Rocks

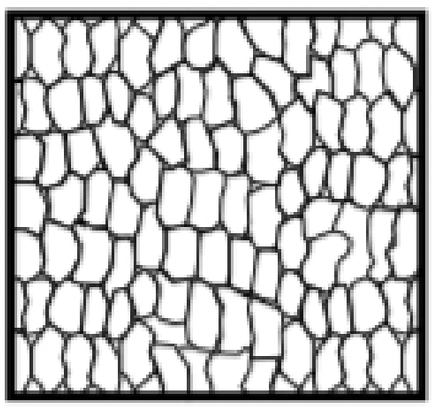
When sediment is transported and deposited, it leaves clues to the mode of transport and deposition. For example, if the mode of transport is by sliding down a slope, the deposits that result are generally chaotic in nature, and show a wide variety of particle sizes. Grain size and the interrelationship between grains gives the resulting sediment texture. Thus, we can use the texture of the resulting deposits to give us clues to the mode of transport and deposition.

Sorting - The degree of uniformity of grain size. Particles become sorted on the basis of density, because of the energy of the transporting medium. High energy currents can carry larger fragments. As the energy decreases, heavier particles are deposited and lighter fragments continue to be transported. This results in sorting due to density.

If the particles have the same density, then the heavier particles will also be larger, so the sorting will take place on the basis of size. We can classify this size sorting on a relative basis - well sorted to poorly sorted. Sorting gives clues to the energy conditions of the transporting medium from which the sediment was deposited.



Poorly Sorted Sediment

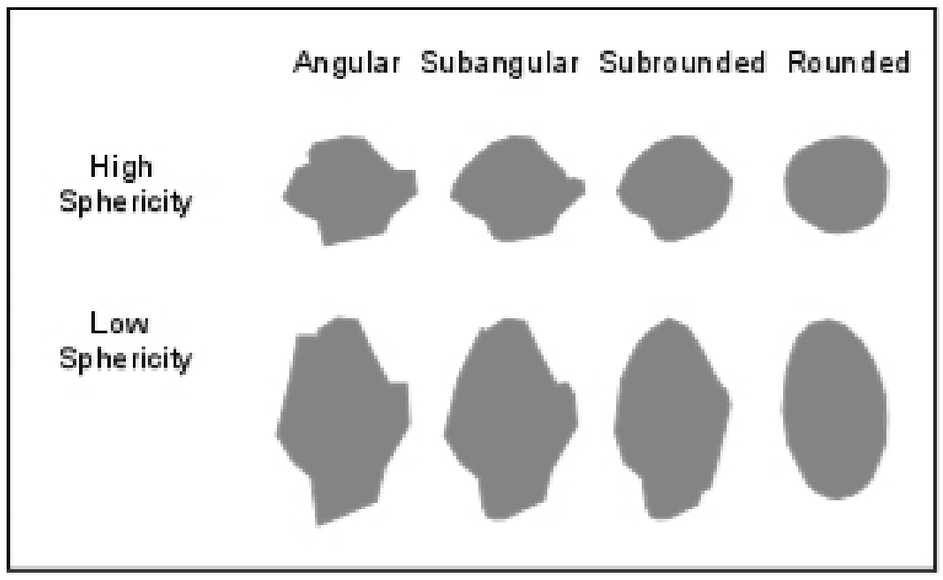


Well Sorted Sediment

Examples

- Beach deposits and wind blown deposits generally show good sorting because the energy of the transporting medium is usually constant.
- Stream deposits are usually poorly sorted because the energy (velocity) in a stream varies with position in the stream and time.

Rounding - During the transportation process, grains may be reduced in size due to abrasion. Random abrasion results in the eventual rounding off of the sharp corners and edges of grains. Thus, rounding of grains gives us clues to the amount of time a sediment has been in the transportation cycle. Rounding is classified on relative terms as well.



Sediment Maturity

Sediment Maturity refers to the length of time that the sediment has been in the sedimentary cycle. Texturally mature sediment is sediment that is well rounded, (as rounding increases with transport distance and time) and well sorted (as sorting gets better as larger clasts are left behind and smaller clasts are carried away. Because the weathering processes continues during sediment transport, mineral grains that are unstable near the surface become less common as the distance of transport or time in the cycle increases. Thus compositionally mature sediment is composed of only the most stable minerals.

For example a poorly sediment containing glassy angular volcanic fragments, olivine crystals and plagioclase is texturally immature because the fragments are angular, indicating they have not been transported very far and the sediment is poorly sorted, indicating that little time has been involved in separating larger fragments from smaller fragments. It is compositionally immature because it contains unstable glass along with minerals that are not very stable near the surface - olivine and plagioclase.

On the other hand a well sorted beach sand consisting mainly of well rounded quartz grains is texturally mature because the grains are rounded, indicating a long time in the transportation cycle, and the sediment is well sorted, also indicative of the long time required to separate the coarser grained material and finer grained material from the sand. The beach sand is compositionally mature because it is made up only of quartz which is very stable at the earth's surface.

Types of Clastic Sedimentary Rocks

We next look at various clastic sedimentary rocks that result from lithification of sediment.

Conglomerates and Breccias

Conglomerate and Breccia are rocks that contain an abundance of coarse grained clasts (pebbles, cobbles, or boulders). In a conglomerate, the coarse grained clasts are well rounded, indicating that they spent considerable time in the transportation process and were ultimately deposited in a high energy environment capable of carrying the large clasts. In a breccia, the coarse grained clasts are very angular, indicating the the clasts spent little time in the transportation cycle.